In-situ detection and control of capillary flow and micro-scale reaction for space propulsions

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Microfluidics technology has played significant roles on the development of advanced micropropulsion devices and micropower generators, including micro thrusters, MEMS electrosprays, and fuel cells. Micro-scale propellant distributions, and associated flow controls and reactions are among their significant technical challenges. This work explores *in-situ* micro droplet formation and dynamics in fuel cells, and presents the visualization results of the liquid flow and transport on the hydrophilic and hydrophobic surfaces in porous diffusion media and micro flow channels. Nano-scale molecular monolayers and surface treatments are introduced to enhance capillary effects and flow control. Micro-scale reaction enhancement and performance evaluation will also be discussed. Emphasis will also be given to the design guidelines for better capillary flow control coupled with microfluidics technology. Based on these guidelines, the development of a nano-based device with tunable flow pathways is described at the final part.